

Research of the arcs lengths system regulation modes of an electric arc furnace with the neuro-controllers

Jaroslav Paranchuk[†], Andrii Matsygin^{*}

[†] Faculty of Electrical Engineering, Lviv Polytechnic National University, 12 St. Bandera St., 79013 Lviv, Ukraine

^{*} Faculty of Electrical Engineering, Lviv Polytechnic National University, 12 St. Bandera St., 79013 Lviv, Ukraine, E-mail: matsygin@ukr.net

Abstract The elaborated system of regulating the arcs lengths of an arc furnace with NARMA-L2 Controller, NN Predictive Controller, Model Reference Controller and the obtained results of computer simulation of electric mode for the existing and proposed systems have proved the improvement of indicators of dynamics of regulation of the arcs lengths compared with a serial power regulator – AFAR-T.

Keywords Steel-making arc furnace, neuro-controller, computer model, arc power regulator, dynamics.

I. INTRODUCTION

The solution of the problem how to increase electric-technological efficiency of steel arc furnaces control modes (EAF) is stipulated by the need to improve its overall technical and economic performance indicators. The main requirement towards automatic control mode of melting is the need for high-quality EAF stabilization coordinates of electric mode (EM).

Electric arc furnaces are evident non-linear objects with non-stationary stochastic load. Creation of accurate mathematical models of their modes is overly complicated and in many cases is a problem beyond solution.

Therefore, the most appropriate and effective solution to this problem is use of the newest methods of optimal control, in particular the implementation of such control based on the theory of neural networks methods.

II. PROPOSED SOLUTIONS

To improve dynamic indicators the authors propose the electro-mechanical system of regulating the arcs lengths with a neuro-regulator. In this system the DC-motor, through the reducer, carries out the transition of the electrode, thus regulating arcs lengths and, consequently, voltage, current and arc power. Electric drive of electrodes transition is realized according to the scheme “thyristor transformer – DC-motor” with the forming negative feedback for current and the motor speed, and the mechanism of the electrode transition is the “pinion-rake” type. The kinematic scheme is close to being balanced. The moment of the static workload includes the reactive moment of friction, a short moment of the moving masses imbalance and a considerable dynamic moment. The regulation is executed according to the differential law of regulation [1]:

$$U_{dif} = K_u U_a - K_i I_a \quad (1)$$

where: U_a, I_a – the alternating values of the arc voltage and current, K_u, K_i – stable coefficients which designate stable electrical mode.

The neuro-regulator is activated at the thyristor transformer input of the electric drive electrode transition.

It is constant and it forms the regulation signal $U_c = f(U_{dif})$ [2].

III. RESEARCH RESULTS

The comparative analysis of efficiency of the proposed system of regulating the EAF arcs lengths with a neuro-regulator and the existing system (of arc power regulator) of the AFAR-T type has been carried out on the created digital Simulink-models in the medium of the MatLab applied program package.

The obtained results of model studies have shown that use of the developed structure of control system electric mode of EAF with neuro-controllers enables to increase dynamic accuracy of electric mode stabilization coordinates at set levels in a continuous occasional disturbance according to an arc's length. The time of control when causing occasional disturbances are reduced by 30-40%, and the dispersion of electric mode coordinate in quasi-set modes when causing occasional disturbances according to an arc's length is reduced by 1.4-1.6 times. Time control decreased approximately twice whereas the integral quadratic indicator of quality control of deterministic disturbances decreased 1.5 times.

Thus, a significant improvement of integral quadratic indicators of quality dynamics control of an arc's voltage and current causes reduction of power losses in the elements of short network, decreases negative impact of an arc's performance on the quality of electricity indicators on the arc furnace cables supply, increases arc's power and reduces specific energy consumption, etc.

IV. CONCLUSION

The use of the neuron network for the operational synthesis regulation signal for the transition of electrodes is an efficient approach towards a complex improvement of the electro-technological efficiency indicators and electro-magnetic compatibility of the EAF and optimal strategies of regulating steel-making modes in an EAF

V. REFERENCES

- [1] Sventchansky, A., Kruchinin M., Automatic control of electrothermal installations: The textbook for universities, “Energoatomizdat”, 1990.
- [2] Medvedev, S., Potyomkin G., “MATLAB 6 neuro-networks”, M.: DIALOG – MIPHI, 2002.